JC13 Rec'd PCT/PTO 08 JAN 2002

FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER 217470US6PCT
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 10/030272
INTERNATIONAL APPLICATION NO. **PCT/FR00/02014**	INTERNATIONAL FILING DATE **12 June 2000**	PRIORITY DATE CLAIMED **12 July 1999**

TITLE OF INVENTION

PROCESS FOR SEPARATION OF TWO ELEMENTS AND DEVICE FOR ITS IMPLEMENTATION

APPLICANT(S) FOR DO/EO/US

RAYSSAC Olivier et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☐ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

   Request for Consideration of Documents Cited in International Search Report PCT/IB/304/Drawings (8 sheets)/PCT/IB/308/Notice of Priority

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 10/030272	INTERNATIONAL APPLICATION NO. **PCT/FR00/02014**	ATTORNEY'S DOCKET NUMBER **217470US6PCT**

24. The following fees are submitted:.

	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :		
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**		
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$890.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	29 - 20 =	9	x $18.00	**$162.00**	
Independent claims	3 - 3 =	0	x $84.00	**$0.00**	
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$1,052.00**	
☐ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.				**$0.00**	
SUBTOTAL =				**$1,052.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				**$0.00**	
TOTAL NATIONAL FEE =				**$1,052.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐				**$0.00**	
TOTAL FEES ENCLOSED =				**$1,052.00**	
				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of **$1,052.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. ______ in the amount of ______ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **15-0030** A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

22850

SIGNATURE

Gregory J. Maier

NAME

25,599

REGISTRATION NUMBER

James D. Hamilton
Registration No. 28,421

1/8/02

DATE

217470US6-PCT

#3/a

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF	:
OLIVIER RAYSSAC ET AL	: ATTN: APPLICATION DIVISION
SERIAL NO: NEW U.S. PCT APPLICATION (Based on PCT/FR00/02014)	:
FILED: HEREWITH	:
FOR: PROCESS FOR SEPARATION OF TWO ELEMENTS AND DEVICE FOR ITS IMPLEMENTATION	:

PRELIMINARY AMENDMENT

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

Prior to a first examination on the merits, please amend the above-identified application as follows:

IN THE CLAIMS

Please cancel Claims 1-29 without prejudice.

Please add new Claims 30-58 as follows:

30. (New) A process for separation of two elements of a structure containing the two elements brought into adherent contact with one another by respective bonded adherent faces and with at least one interface;

wherein the process involves, before the elements are brought into adherent contact, carrying out of at least one cavity, said cavity being made in at least one of the elements and

emerging respectively at the interface, so as to enable passage in the cavity of separation means; and wherein the process also involves, at separation, exertion of a force, in a localized manner at the interface, by application of the separation means, to initiate separation of the two elements starting at the interface, and to continue the separation process, if applicable, until complete separation of the two elements.

31. (New) A separation process in claim 30, in which the separation of the two elements is induced in one or more interfaces, in a simultaneous or sequential manner.

32. (New) A separation process in claim 30, wherein the separation means contains means for exerting a mechanical action at the interface.

33. (New) A separation process in claim 30, wherein the separation means contains means for exerting a fluid pressure at the interface.

34. (New) A separation process in claim 30, wherein the separation means contains means for exerting a chemical action on at least one of the elements at the interface.

35. (New) A separation process in claim 30, wherein the cavities are obtained by engraving.

36. (New) A separation process in claim 30, in which the adherence faces define at least one of interface zones, and in which the cavities are made at a periphery of at least one element, in the adherence faces.

37. (New) A separation process in claim 30, wherein the cavities are made in an inner region of at least one element, at the interface.

38. (New) A process in claim 30, wherein at least one cavity penetrates through at least one element from side to side.

39. (New) A separation process in claim 30, wherein, where several interface zones are planned and are arranged so as to initiate the separation at determined locations of the interface.

40. (New) A separation process in claim 37, wherein, with the fluid being a liquid fluid, the separation means involve microwave excitation of the liquid fluid.

41. (New) A separation process in claim 30, wherein the two elements adhere to one another with a different adherence energy in different regions of an adherence interface between the elements, so as to initiate separation at a determined location of the adherence interface.

42. (New) A separation process in claim 30, for separating two elements of a structure having at least a first interface formed at the adherence faces of the two elements, and at least one second interface formed in at least one of the elements, in which a separation of the structure is induced at one of the first and second interfaces.

43. (New) A separation process in claim 42, for the separation of a structure with a bonding energy in the second interface lower than a bonding energy of the first interface, in which a separation of the structure in the second interface is induced.

44. (New) A separation process in claim 42, in which, before the two elements are brought into contact, an embrittled zone is formed in at least one of the two elements forming the second interface.

45. (New) A separation process in claim 44, in which the embrittled zone is formed using an implantation technique or using a layer adherence technique.

46. (New) A separation process in claim 45, in which the embrittled zone is formed at a shallow depth in one of the elements such that the second interface delimits a thin layer in the element.

47. (New) A device for separating two elements of a structure, adhering to one another by adherence faces at least one of which has cavities in an interface zone so as to be configured to subject at least one of the adherence faces to influence of at least one of a fluid and a mechanical action, where the device contains an enclosure with at least one high-pressure chamber, configured to receive the fluid, and at least one low-pressure chamber, and where the enclosure is formed so as to receive the two adherent elements such that the cavities communicate with the high-pressure chamber.

48. (New) A separation device in claim 47, further comprising means for forming a stop on occurrence of deformation judged to be excessive of at least one of the two elements of the structure when they are separated.

49. (New) A separation device in claim 47, wherein the means for holding the structure contain at least one joint arranged between an element of the structure and a wall of the enclosure.

50. (New) A separation device in claim 49, in which at least one joint is arranged between a main face of at least one element in a form of a plate and a wall of the enclosure facing the main face.

51. (New) A separation device in claim 49, in which at least one joint is arranged between an edge of at least one element in a form of a plate and a wall of the enclosure facing the edge.

52. (New) A handle for transferring objects including an adherence face with cavities in at least some interface zones, and to which objects can adhere, and including means of access to interface zones in order to separate the objects.

53. (New) A transfer handle in claim 52, including a plate, one face of which constitutes the adherence face, and where the plate is pierced with holes which penetrate

through, emerging at the interface zones and constituting the means of access to the interface zones.

54. (New) A transfer handle in claim 53, wherein the penetrating holes are holes allowing a tool for separating the objects to pass through.

55. (New) A transfer handle in claim 52, wherein the means of access to the interface zones are channels for application of a pressurized fluid.

56. (New) A transfer handle in claim 55, containing channels for application of a fluid made in the adherence face and formed according to a concentric circle pattern, a spiral pattern, a radial pattern, or a diagonal intersecting pattern between sectors of the adherence face.

57. (New) A transfer handle in claim 55, in which the channels constitute at least one of cavities and link cavities made in the adherence face.

58. (New) A process for transferring objects made on a surface of a first substrate, where the objects have an adherence face, and the process comprises the following stages:

adherence faces of one or more objects are brought into contact with the adherence face of a transfer handle in claim 50,

possibly, the first substrate is thinned on a free face of the first substrate,

at least one of the objects is brought into adherent contact with a receiving substrate,

the object is separated from the handle.

IN THE ABSTRACT

Please amend the Abstract on page 41 as follows:

ABSTRACT

A process for separating two elements of a structure put in adherent contact one with the other by respective adherent faces. The process includes a stage of application of a force, in a localized manner in an interface zone, by the bringing into contact, in the interface zone, one and/or the other of the faces with separators to initiate the separation of the two elements in the interface zone, and to continue, if applicable, until complete separation of the two elements.

REMARKS

Favorable consideration of this application, as presently amended, is respectfully requested.

The present Preliminary Amendment is submitted to place the above-identified application in more proper format under United States practice.

By the present Preliminary Amendment original Claims 1-29 are cancelled and new Claims 30-58 are presented for examination. New Claims 30-58 are deemed to be self-evident from the original disclosure, including original Claims 1-29, and thus are not deemed to raise any issues of new matter.

The Abstract has also been amended by the present response to correct minor informalities.

The present application is believed to be in condition for a full and thorough examination on the merits. An early and favorable consideration of the present application is hereby respectfully requested.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.

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Marked-Up Copy
Serial No:

Amendment Filed on:
1-8-2002

IN THE CLAIMS

Claims 1-29 (Cancelled).

Claims 30-58 (New).

IN THE ABSTRACT

Please amend the Abstract on page 41 as follows:

--ABSTRACT

[The invention relates to a] A process for separating two elements [(1, 2)] of a structure put in adherent contact one with the other by respective adherent faces[, where the]. The process includes a stage of application of a force, in a [localised] localized manner in an interface zone [(17)], by the bringing into contact, in the interface zone [(17), of], one and/or the other of the [said] faces with separators to initiate the separation of the two elements in the interface zone, and to continue [it], if applicable, until complete separation of the two elements.

[Fig. 3A.]--

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PROCESS FOR SEPARATION OF TWO ELEMENTS AND DEVICE FOR ITS IMPLEMENTATION

Technical field

The present invention relates to a process for separating two elements adhering one to the other by means of adherent faces, with this separation being able to be obtained under the action of a fluid and/or a mechanical element allowing the separation to be initiated locally. It also relates to a device for implementation of this process.

The invention applies in particular to the field of micro-electronics in order to separate two plates adhering one to the other. It is of particular interest in handling thin, fragile and very flexible plates.

State of prior technique

Document FR-A-2 752 332 discloses a process for separation of a support plate by the insertion, at the bonding interface, of a quite flexible separator element so as not to scratch the surfaces. This separator element consists of several parts allowing minimum optical sighting, during the operation to open the interface, to be compatible with an industrial goal. This process was developed for plates bonded by means of attractive forces.

The article entitled "Bonding of silicon wafers for silicon-on-insulator" by W.P. MASZARA et al., published in the review J. Appl. Phys. 64 (10), 15 November 1988, pages 4943-4950, relates to the measurement of bonding energy by the method of the blade inserted at the interface of two elements adhering one to the other. For a given bonding energy, the thicker the blade, the further the opening wave propagates from the opening point at the bonding interface. Similarly, the greater the bonding energy, the less the separation wave propagates for a given blade thickness.

To apply a separation process as described in document FR-A-2 752 332, it is advantageous if the surface energy is low and the separator element is thick. A separation wave may thus be propagated over a significant length compared to the diameter of the plates for separation.

However, use of a thick separator element may lead to a fracture of one of the plates due to the curvature radius being too low. In addition, it has been shown that the greater the bonding energy, the more the blade or the separator element must be inserted gently in the interface to prevent the risk of fracture of the plates, relaxation of the opening stresses being made possible through a sufficiently slow opening.

In addition, in the case of a structure with several interfaces, the opening may be propagated from one interface to another, associated, for example, with a lower bonding energy.

It is also known that the bonding energy between two elements increases when a thermal treatment is applied. On this subject one may refer to the article by C. MALEVILLE et al., published in the review Electrochemical Society Proceedings Volume 97 - 36, pages 46-55. As an example, silicon plates the surfaces of which have been made hydrophilic are bonded to one another. A bonding energy greater than 1 J/m^2 is obtained for bondings followed by thermal treatment at 1000°C. Thus, for silicon plates 525 μm thick (typical thickness of plates of 100 mm diameter), a blade 600 μm thick succeeds in causing an opening of the bonding interface over a length of around 3 cm or less. This length of opening is insufficient to separate the plates. It is then necessary to introduce a thicker separator to propagate this opening. This causes a reduction of the flexibility of the separator elements and involves the risks mentioned above.

Inserting a blade is not the only method enabling two elements bonded to one another to constitute a structure to be separated. Document WO 98/52 216 describes a process for controlled cleavage of a substrate through the introduction of particles,

originating, for example, from a steam source, from a side of the structure where the interface ends. However, this technique can be used only to separate stacks in which a zone has previously been embrittled, for example by ion implantation. The separation interface can then only be the embrittled zone. American patent No. 5 863 375 discloses the separation of two plates bonded to one another to constitute a structure. Separation is obtained under the effect of a jet of liquid directed on the plane of the interface to a face of the structure where the interface ends.

Moreover, the faces of the plates for separation may have received, before being bonded, one or more deposits of thin films. In this case it is not possible to use the teaching of US patent 5 863 375. The separation liquid jet also acts on deposited films.

As there is no precise location of the bonding interface, the separation may occur in one of the deposited layers if the adherence energy of a film to its plate is less than the adherence energy of the bonding interface between the two plates. This technique is also very expense in terms of the consumption of fluid used, since a large quantity of this fluid does not act on the bonding interface.

These known techniques for separation using a jet of particles or a jet of liquid replacing a separating blade

reveal other problems. A first problem relates to the precise location of the opening interface. Other problems are related to the fact that to apply the opening techniques easily the bonding interface must not be too resistant taking account of the various thermal treatments which can be applied.

Traditionally, the bonding energy may be controlled by preparing the surfaces to modify their hydrophilic character or their roughness. On this subject, one may refer, for example, to the document "influence of surface characteristics on direct wafer bonding" by O. Rayssac and coll., 2nd international conference on materials for micro-electronics, 14/15 September 1998, ION Communications Ltd.

Document EP-A-0 703 609 discloses a process for transferring a thin semiconducting layer from a support substrate to a target substrate, taking advantage of the fact that the bonding energy between the layer and the support substrate is less than the bonding energy between the layer and the target substrate. When a pulling and/or shearing and/or torsion force is applied to the structure, the separation occurs between the layer and the support substrate, thus causing the layer to be transferred.

This process must, as above, take account of the possible problem of resistance of the bonding interface.

In addition, the thin layer is bonded to the support substrate in order to undergo a number of processes including, for example, one or more deposits of thin films the adherence energy of which may prove to be lower than the bonding energy of the substrates to each other. In particular, methods of separation based on traction, shearing or torsion, applied globally to the substrates, may not be used.

Account of the invention

The invention has been designed to remedy the disadvantages reported above.

To this end, the invention relates more specifically to a process for separating two elements of a structure containing both elements put in adherent contact with one another by respective adherent faces and with at least one interface.

Before adherent contact is accomplished, the process involves at least one cavity being made. The cavity is made in at least one of the elements, ending respectively at the interface, to allow separators to pass into the cavity. The process also comprises, during separation, the exercise of a force, in a localised manner in the interface, through the application of the said separators to initiate the separation of the two elements from the

interface and to continue it, if applicable, until complete separation of the two elements.

The separators may include, among other things, means exerting a mechanical action and/or fluid pressure and/or exerting a chemical action on at least one of the adherent faces at the interface.

Thus, the force applied to the interface must be understood as resulting from a mechanical and/or fluid pressure and/or chemical action.

The cavities may be obtained by engraving. They may be made on the periphery or in a more central region of the elements. In particular they may be distributed across all or part of an interface of adherence between the elements, so as to control propagation of the separation opening. The cavities may also extend as far as an interface separate from that formed by the elements' adherence faces, inside one of the elements.

If several interfaces are used for the separators, the cavities may be arranged so as to initiate the separation at a given location of the interfaces.

When the separators include means exerting a fluid pressure in the interface zone, and when this fluid is liquid, these separators may include microwaves or impulse excitation of the liquid fluid.

The two elements may be put into adherence with one another with an adherence energy which varies according to the various regions of the adherence interface so as to initiate the separation at a given location of the interface.

In addition, the separators may be such that the separation of the two elements in the interface occurs at one or more locations in a simultaneous or sequential manner.

The invention also relates to a device for separating two elements of a structure, adhering to one another by adherence faces at least one of which has cavities in an interface zone, so as to be able to subject at least one of the adherence faces to the influence of a fluid and possibly to a mechanical action, with the device comprising an enclosure with at least a first chamber called a high-pressure chamber able to receive the fluid, and a second chamber, called a low-pressure chamber, the enclosure being formed so as to receive both the adherent elements of the structure such that the cavities communicate with the high pressure chamber.

This device may also include means forming a stop to a deformation considered excessive of one and/or the other element of the structure on their separation.

The enclosure may, preferably, be fitted with at least one joint arranged between an element of the structure and the wall of the enclosure to separate the high-pressure chamber from the low-pressure chamber.

The invention also relates to a handle for transferring objects such as, for example, electronic chips. The handle has an adherence face with cavities in at least one interface zone, to which objects may adhere, and the handle also has means of access to the interface zones to separate objects from them. The objects are of various dimensions, from a few microns to several tens of centimetres for example.

The means of access are, for example, channels or any other type of depression or perforation made in the adherence face.

The handle may contain a plate one face of which constitutes the adherence face, with the plate being pierced with penetrating holes ending in the interface zones and constituting the said means of access to the interface zones. The penetrating holes may be holes allowing a tool for separating objects to be passed through.

The means of access to the interface zones preferably allow a fluid pressure to be applied to the objects.

A fourth goal of the invention relates to a process for localised transfer of objects made on the surface of a first substrate, with an adherence face, where the process comprises the following stages (in this order or in another order):

- putting the adherence face of one or more object in adherent contact with the adherence face of a transfer handle as described above.

- possibly, thinning of the first substrate from the free face of this first substrate,

- placing into adherent contact of at least one of the said objects with a receiving substrate, and

- separation of the said object from the handle using the means of access to the interface zone,

The process may be completed by the separation of the transfer handle, which may contain objects which are not yet transferred, and of the receiving substrate which contains the transferred objects.

If the objects are not separated from one another, i.e. clipped before the placing into adherent contact with the receiving substrate, the process may also include a stage of clipping of objects so as to allow their individual transfer.

Brief description of the drawings

The invention will be better understood and other advantages and features will appear on reading the following description, given as a non-limiting example, accompanied by the annexed drawings, among which:

- figure 1A represents, as a transverse section, a first possibility for embodiment of a device according to the invention intended for separating two elements adhering to one another,

- figures 1B and 1C are partial schematic sections illustrating possible variants for embodiment of the device of figure 1A.

- figure 2 represents, seen as a transverse section, a second possible embodiment of a device according to the invention intended for separating two elements adhering to one another,

- figures 3A to 3C illustrate the conduct of the process of separating two elements adhering to one another, according to the invention,

- figures 4A to 4D illustrate application of the process according to the invention for obtaining a semi-conductive membrane, the main faces of which receive treatments using micro-electronics techniques,

- figures 5A to 5F illustrate the transfer of an electronic chip from a first substrate to a receiving substrate using the process according to the present invention,

- figures 6 to 12 illustrate schematically various possibilities for forming an adherence face of an element of a structure, for use in separation in accordance with the invention,

- figure 13 is a transverse section of a structure formed from two elements and with two interface zones for a separation in accordance with the invention,

- figure 14 is a view from above of an adherence face of an element of a specific structure for use in a separation,

- figure 15 is a schematic section of a structure including the element of figure 14.

Detailed description of embodiments of the invention

The invention allows the separation of two elements the adherence surfaces of which may be bonded by means such as, for example, glues (polymers, epoxy, etc.) or bonded by molecular adherence. The invention applies particularly well to the case in which these elements are plates and notably if one of these plates is a semi-conductive plate the two principal faces of which may receive a treatment using micro-electronics techniques.

The idea consists in introducing a means, notably a fluid and/or a mechanical tool, around the bonding interface so as to cause an action allowing all or part of the elements to be separated, offering the choice of being able to locate the interface zone for separation in the first place. A fluid may, for example, be introduced at the interface, using an engraving undertaken prior to the bonding in one of the elements or in both. Tests have shown that an engraving of this kind may be undertaken without hindering the bonding. To allow the introduction of a fluid, this engraving must communicate with the outside. It may be communicating at the periphery or through one of the elements. The separation may thus be initiated in the vicinity of the engraved zone.

The engraving may be undertake to constitute, for example, a network of blocks, a network of cavities,

whether or not penetrating, or take a spiral shape or a ring shape or a shape in sectors. These various possibilities are illustrated by figures 6 to 12 described below.

The fluid may be introduced using an adapter in the cavity made by engraving, or by placing the structure formed from the two bonded elements in an enclosure filled with fluid the pressure of which is controlled.

Figure 1A shows in section a first possibility of embodiment of a device according to the invention allowing the separation of two elements. In the example of the figure, the elements are two circular plates 1 and 2 bonded to one another with an interface 3. The device contains a sealed enclosure 4 of cylindrical shape with a lower wall 5 and an upper wall 6. Joints, for example toric joints, 7 and 8, are fixed respectively to the lower wall 5 and upper wall 6 and support the main faces of the plates. the device is dimensioned according to the size of plates 1 and 2 which are to be separated. The device is connected laterally to a duct 9 for conveying fluid, on to which is mounted a valve 10.

When the structure consisting of plates 1 and 2 bonded to each other is installed in the device, enclosure 4 is divided into several chambers: a chamber 11 called the high-pressure chamber, for receiving the fluid conveyed by duct 9, and two chambers 12 and 13

located respectively above and below the structure for separation, and called low-pressure chambers.

The pressure which the fluid must exert to cause the separation depends on the adherence energy between the plates. In the case of a molecular adherence, the latter is determined in particular by preparing the surfaces before bonding and also by the thermal treatment(s) undergone by the structure. To remain within the limit of elastic deformation and not to deform the plates irremediably, it is possible to alter the distance between the bonded structure and the inner surface of the enclosure located opposite the plates. Stops 14 and 15 fixed on the inner surface of the enclosure allow the deformations caused in the plates to be limited, and may favour separation. The initial distance between the stop and the corresponding plate depends notably on the thickness of the plate and its nature.

Figure 1A shows that plate 2 contains a peripheral engraving 16 allowing the fluid to reach an interface zone 17.

References 18 and 19 designate ducts respectively in communication with the low-pressure chambers 12 and 13, which can be designed to control the pressure of a fluid located in these chambers. Ducts 18 and 19 can be simple vents, able to be put in communication, for example with the atmospheric pressure. They can also be linked to

means for adjusting the pressure of a fluid, for example a gas located in the low-pressure chambers, so as to control the separation precisely. The pressure of the fluid in the low-pressure chambers is, however, maintained at a lower value than the pressure of the fluid applied to the high-pressure chamber, to allow separation.

Figure 1B shows, in a partial manner, and on a larger scale, another possible embodiment of the separation device constituting a variant compared to figure 1A. The identical parts, similar or corresponding to that of figure 1, are identified with the same numerical references and their account is not given here.

It is observed in figure 1B that joints, for example toric joints, 7 and 8 are not fixed on the upper and lower walls of the device but on the lateral walls which are facing the plate's edges.

Joints 7 and 8 rest respectively on the edges of the plates at a sufficient distance from the bonding interface so as not to hinder access of the pressurised fluid to the peripheral engraving 16 and thus to the interface zone 17.

The action of the fluid on the adherence faces in the interface zone is indicated by arrows. Arrows also

indicate the separation of the plates pushed back towards the low-pressure chambers 12 and 13.

Figure 1C also shows, in a partial manner and on a larger scale, yet another possible embodiment of the separation device, constituting a variant in relation to figures 1A and 1B. The parts identical or similar to those of the previous figures are always indicated with the same references.

It is observed in figure 1C that the toric joints have been eliminated and replaced by a lip joint J. Joint J provides sealing between the lateral wall of the device and the first and second plates. It also provides sealing between the high-pressure chamber 11 and the low-pressure chambers 12 and 13.

A passage P made in joint J allows the pressurised fluid to reach the interface zone 17 of plates 1 and 2.

Figure 2 shows yet another possible embodiment of a device according to the invention allowing the separation of two circular plates 21 and 22 bonded one to another with an interface 23. A duct 29 conveying fluid is connected differently from that of figure 1A. It leads to the centre of the lower wall 25 of enclosure 24. This device divides enclosure 24 into a high-pressure chamber 35 and into two low-pressure chambers: chamber 31 and chamber 32 and in which plate 21 may be deformed.

Figure 2 shows that plate 22 has a central penetrating hole 26 allowing the fluid to reach an interface zone 37. The central hole may be replaced and/or completed by other holes penetrating the plate (with identical or different diameters).

Figures 3A to 3C illustrate an example of the conduct of the process of separation of plates 1 and 2 in figure 1. At the start of the operation, the fluid is introduced and starts to exert its action on the walls of cavity 16 and the interface zone 17 as is shown by the arrows in figure 3A. Figure 3B shows an example of the commencement of the separation between plates 1 and 2 under the action of the fluid pressure and the role of stops 14 and 15. Plate 1 in this example is deformed more than plate 2. This example occurs in the case where one plate is finer than the other. Thus, in the case of power electronic applications, it is possible, thanks to the invention, to produce and manipulate membranes of several tens of micrometers. Figure 3C shows plates 1 and 2 totally separated.

In the cases represented in figures 1 and 2, plates 1 and 21 are, for example, elements or membranes in which circuits can be produced whereas plates 2 and 22 are elements reserved for the separation operation. Plates 2 and 22 can be designated under the name transfer handles. These handles are easy to re-use.

The advantage of locating the engraving in the plate used as a handle is that, in addition to localising the separation of the structure horizontally, this allows the interface to be localised vertically in the structure. As indicated above in the state of prior technique, if layers have been deposited before the plates are bonded (see the layers shown in dot-and-dash lines in figure 1) and if these layers have lower adherence than the bonding interface, only this vertical location will allow separation at the bonding interface.

To increase the fluid's effectiveness, it may be advantageous if, in addition to the pressure action, this fluid is able to exert a chemical action in the interface, thus facilitating separation. For an interface with a silicon oxide base, a solution formed from HF diluted in water may be used to control the speed of engraving. If a face for separation must be preserved (a face treated by micro-electronics techniques, for example), the part to be preserved may be protected by a stop layer (for example, polycrystalline silicon) on which the interface oxide is deposited or formed.

In addition, in the case of a liquid fluid, the separation may be facilitated, for example, through the use of an excitation of the microwave type, pulse type, etc.

It may be advantageous to prepare one of the adherence faces of at least one of the plates, partly or wholly, in order that the resulting bonding energy varies in the plane of the bonding interface. It is possible, for example, to define a central zone of the interface where the adherence will be stronger than in the periphery. This energy difference will be exploited to induce the subsequent separation by localising the commencement of separation in the periphery of the structure. More generally, this technique may be used advantageously to generate localised zones where the bonding energy is different to the bonding energy of the other zones.

Figures 4A to 4D illustrate the acquisition of a membrane, for example made from a semi-conductive membrane, the main faces of which are treated using micro-electronics techniques. The goal is to obtain a membrane approximately, for example, 100 μm thick, treated on both faces from a standard 4-inch silicon plate 525 μm thick. This plate will have to be subjected to various operations, for example thermal annealings (typically at 1100°C), mechanical treatments (polishing, surface treatments), chemical treatments (dry or wet engraving), deposits (oxides or metals), and implantations.

These various operations imply manipulations of the membrane, which is problematic when it is around 100 μm

thick or less. The invention enables this problem to be overcome.

Figure 4A shows a silicon plate 40 intended to supply a membrane. The plate is represented with one of its main faces, face 41, which has previously undergone treatments using micro-electronic techniques, and which has received, for example, an encapsulating oxide layer. The oxide layer may possibly be polished to give a flat surface.

Figure 4B shows plate 40 (in a reversed position in relation to figure 4A) put in contact by its face 41 with face 48 of a plate 49. Plate 49 is ideally a plate of oxidised silicon. Bonding by SiO_2/SiO_2 hydrophilic molecular adherence may thus be obtained. The bonding energy may be controlled by varying the more or less hydrophilic or more or less rough nature of the surfaces. It is then possible to undertake operations using micro-electronic techniques with the other face, face 42, of plate 40, in perfect safety from the mechanical standpoint to obtain finally a membrane treated on both faces.

As indicated above, to obtain the desired molecular adherence, it is possible to modify the hydrophilic nature and/or roughness using traditional techniques. By combining both methods, after annealing at 1100°C, it is possible to obtain a bonding energy of around 500 mJ/m^2

for an SiO_2/SiO_2 structure the surface roughnesses of which are typically 0.6 nm RMS (root mean square). This value is substantially less than that (2 J/m^2) obtained for bonding of plates the surface roughness of which is around 0.2 nm. With this bonding energy value, the process of the invention allows plate 40 to be separated from plate 49 and a fine membrane to be obtained finally which has been subjected to at least one treatment on at least one of its faces, with a minimal risk of deterioration.

As yet another example, this technique may be used advantageously to generate localised zones the bonding energy of which is different from the bonding energy of the remainder of the structure. The variation of the bonding energy, in different zones, may be obtained by a technique using partial masking of at least one of the surfaces in contact in the bonding. For example, it is possible to generate different surface roughnesses in masked and non-masked zones by a chemical attack, a dry engraving, an ion implantation, etc.

The roughness may advantageously be controlled so as to cause the lowest bonding energy in the zone(s) chosen for the commencement of separation.

Plate 49 (see figure 4B) has an engraved part 47 forming an example of a cavity of the recess type, giving

access to an interface zone 43 on which a fluid pressure may be exerted.

Figure 4C shows the structure obtained successively by surface treatment and possibly polishing of plate 40 in order to transform this plate into a membrane 44.

Free face 45 of membrane 44 can then be treated by micro-electronic techniques. A membrane treated on both faces is obtained (see figure 4D), which will be separated from plate 49 in accordance with the invention.

In conceivable treatments it is possible to make deposits of layers or engravings, or even transfer another structure on to the membrane, notably to rigidify it.

For certain applications, for example in optoelectronics, it appears to be advantageous to be able to associate a chip or optoelectronic component produced, for example, on III-V material with an electronic circuit produced for example on silicon. In this case, to produce an object of this kind, one approach consists in transferring the chip made of III-V material to a whole plate containing the circuits. The transfer to a whole plate allows the implementation of technological stages subsequent to the transfer. As an example, one can mention, among the operations subsequent to the transfer, those allowing contacts to be made between, for example,

the chip and the circuit. The invention allows electronic chips to be transferred to whole plates. It has the advantage that it allows chips to be made thinner.

Figures 5A to 5F illustrate the transfer of an electronic chip from a first substrate to a receiving substrate.

Figure 5A shows a plate 50 one of the principal faces of which, face 51, has been treated to produce individualised chips 52. The chips may, for example, be electronic or optoelectronic components. The material of plate 50 may be of type III-V or GaAs. The area of the chips may be of around 250 μm x 250 μm.

Figure 5B shows the joining of plate 50, on the chips side, with a handle plate 53. The joining may be achieved through the bringing into contact with two plates with bonding by molecular adherence or using an intermediate layer of glue or resin. The joining is realised with a controlled bonding energy. For example, in the case of molecular bonding, this energy may be chosen by controlling the surface roughness and/or the hydrophilicity and/or percentage of the area in contact.

If it is desired to transfer chips, handle plate 53 is made such that holes 54 penetrate it, allowing communication between the two main faces of the handle 53 bonded to the chips. The size and pitch of the holes are

appropriate for the size and pitch of the chips. In this example, the pitch of the chips is around 250 μm. The diameter of the holes must be appropriate for the pitch and separation technique. If a tool is used, for example, of the injector needle type, it exerts a mechanical action. If a separation fluid is used, the dimension of the holes may be very small, less than or equal to the dimension of the chips. If the chips are larger, for example 500 μm x 500 μm, the hole dimension may be, for example, 200 μm. Use of an injector needle is then facilitated. Depending on the dimension of the element to be transferred, one or more injector needles may be used. The end of the injector needle may be pointed, flat or conical. The injector needle may also be pierced at the end, for example to convey the fluid. A combination of the fluid and the tool may advantageously be envisaged.

Figure 5C represents the structure obtained after plate 50 is thinned to the desired thickness and chips 52 separated one from the other. If optoelectronic components are produced on a GaAs layer, they may be around 10 μm thick. The separation of the chips may be accomplished by engraving or more simply using a cutting saw.

The thinned structure is brought into contact with a receiving plate 55 (see figure 5D).

As indicated by an arrow in figure 5E, a chip 52 for example may be separated from the handle plate 53 by means of a tool and/or transfer fluid.

When the location of chip 52 for transfer has been prepared on face 56 of the receiving plate 55, separating plates 53 and 55 leaves the chip separated from plate 53 on plate 55, whereas the other chips remain on plate 53.

This process is also of interest for the transfer of thin circuits for smart card or "disposable ticket" applications.

The present invention has many advantages. Firstly, it can allow both sides of (for example) a silicon plate to be worked, without any risk of deterioration. It is thus possible to treat a first face of a plate whilst protecting the second face, by adherence to a support. Subsequently, the treated face may itself be protected by adherence to another support while the other face, after separation, is treated in its turn. This invention can also facilitate use of fine plates, also called membranes (less than 300 μm thick for a diameter of 100 mm). This type of plate is, for example, found increasingly often in micro-electronics applications, and also, for example, in power electronics. The advantage of this type of plate is that it is possible to produce structures made from it while limiting, due to their thinness, problems of thermal heating or leakage current when in use.

Conversely, these plates are places where high stresses occur during use, due to the thermal treatments they undergo and their thinness. It is, for example, very risky to put this type of plate in ovens since they tend to deform and even in extreme cases to break as a consequence of the process temperature and stresses generated by the thermal treatments. In addition, these plates are not always compatible with equipment used in micro-electronics, since the latter are often calibrated to receive plates of standard thickness (for example, 525 μm in the case of silicon plates of diameter 100 mm). Finally, transport and handling of this type of very thin plate must be limited since the risks of breakage are much greater than with standard plates. To remedy these problems, adhering a fine plate to a support plate allows the fine plate to be rigidified to give it the mechanical properties of a thick plate during the various treatment stages. The plates may be dissociated during or after the process.

All the methods described above may apply both to separation of elements of large dimensions (for example, whole plates measuring several centimetres in diameter) and to the separation of elements of small dimensions (for example, several tens of microns in width).

Figures 6 to 12 described below represent in a very schematic way various examples of possible embodiments of the elements of a structure, designed for a separation in

accordance with the invention. These elements are, for example, handles as described above. In all these figures, identical references designate identical or similar parts.

It should be specified that the examples illustrated by figures 6 to 12 are not exhaustive and that the various possible ways of forming cavities shown by these figures may be combined with one another.

Reference 100 designates in a general manner the body of the element or handle which, in the illustrated examples, is represented as a circular plate. A face 102 of the element is also defined, which is the adherence face, intended to be brought into adherent contact with another bonded element to form a structure. The two elements of the structure must also be separated subsequently along the plane of adherence face 102.

Figure 6 shows a first example in which cavities 104a appear as holes penetrating element 100 from side to side to link the adherence face to the opposite face. The holes may have different diameters and different shapes. On the adherence face they define an interface zone allowing preferential localised separation. It is also observed that the holes are made in a more or less central region of the element.

Use of an element 200 in accordance with figure 6 was illustrated previously in a reference to figure 2.

Figure 7 shows an element 100 with a single cavity 104b, which is non-penetrating, in the form of a recess made in the periphery of the element. Cavity 104b corresponds to recess 16 of plate 2 represented in figures 1A to 1C.

Figure 8 shows an element 100 with an adherence face in which broad channels 104c are engraved so as to surround and limit islands 108. The channels 104c allow a pressurised fluid to be applied, but also constitute cavities in the sense of the invention.

Figure 9 shows an element 100 with an adherence face 102 in which several non-penetrating cavities 104d are made to form a network of cavities. The cavities are linked together by channels 104e which lead to the periphery of element 100. The channels 104e also constitute means of access to the interface zone containing the cavities 104d.

Figure 10 shows an element 100 the adherence face 102 of which is divided into sectors by channels 104e extending like spokes. The sectors may themselves be crossed by channels 104f in a diagonal intersecting pattern.

In an alternative embodiment, represented in figure 11, channels may also take the form of concentric circular channels 104g, communicating by a radial channel 104h.

In yet another possibility, represented in figure 12, a circular, spiral-shaped channel 104i may extend from the centre to the periphery of the adherence face 102.

Channels 104e, 104f, 104g, 104h and 104i of figures 10 to 12 allow access of a fluid and/or of a separation tool but also constitute cavities in the sense of the invention. They thus define interface zones allowing privileged localised separation.

The interface zone is determined in a general manner by the positioning and/or distribution of the channels on the element's adherence face.

This distribution also allows the element's adherence with a bonded element, and their subsequent separation, to be controlled precisely. A zone with a high density of channels allows easier separation than a zone with a lower density of channels.

As an example, with a spiral-shaped channel, as represented in figure 12, the ease of separation depends on the distance between the spires. The separation thus

tends to be initiated in the centre of the element and to be propagated in a more or less concentric manner towards the periphery.

This is also the case with the examples of figures 10 and 11.

Figure 13 shows a structure 200 formed from a first element 201 and a second element 202.

The two elements are made to form a single piece by their adherence faces, which thus define a first interface 217.

The first element 201 has undergone ion implantation leading to the formation, at a shallow depth, of an embrittled zone forming a second interface 227, in the sense of the invention.

The embrittled zone extends in a manner more or less parallel to the surface of the first element, i.e. in a manner more or less parallel to its adherence face, thus delimiting a thin surface layer 206 in it.

Emerging cavities 204 are engraved in the first element and extend through the thin surface layer 206 before emerging at the second interface 227.

In the example of figure 13, the bonding force being exerted between the first and second elements, i.e. between their adherence faces, is higher than the bonding force of the second interface 227. The bonding force of the second interface is understood here as the force which must be overcome to cause separation in the embrittled zone.

When a fluid is applied through the cavities 204, the structure in figure 13 will undergo separation, and more specifically separation at the second interface.

Figure 14 shows an adherence face of an element 301 of a structure 300. The latter is designed for the selective transfer of different parts 310 of this element 300.

The parts identified with reference 310 are surrounded with cavities 304 which are partitioned by walls 305 of the first element.

The cavities enable the different parts 310 to be delimited and extend as far as a buried interface, in the form of an embrittled zone as described above.

Figure 15 shows in section element 301, which forms a single piece with element 302, to which the parts 310 must be transferred.

It may be observed that fluid accesses 314 enable the cavities 304 of the first element to be supplied selectively, and these cavities surround some of the parts 310. This enables them to be separated in the second interface 327 and to be selectively transferred to the second element 302.

To this end, it should be specified that only some parts 310 may be made a single piece with the second element 302 at the first interface 317.

Once again in this case, the adherence forces at the first interface 317 are greater than those at the second interface 327, i.e. greater than the forces which must be overcome to detach the parts 310 from element 301.

CLAIMS

1. A process for separation of two elements (1, 2) of a structure containing the two elements brought into adherent contact with one another by respective adherent faces and with at least one interface (17, 217, 227, 317, 327);

wherein the process involves, before the elements are brought into adherent contact, the carrying out of at least one cavity, said cavity being made in at least one of the elements and emerging respectively at the interface, so as to enable passage in the cavity of separation means; and wherein the process also involves, at separation, the exertion of a force, in a localised manner at the said interface (17), by application of the said separation means, to initiate the separation of the two elements starting at the interface, and to continue the separation process, if applicable, until complete separation of the two elements.

2. A process in claim 1, in which the separation of the two elements is induced in one or more interfaces, in a simultaneous or sequential manner.

3. A separation process in claim 1, characterised in that the separators contain means exerting a mechanical action at the interface.

4. A separation process as claimed in any of the claims 1 to 3, characterised in that the separators contain means exerting a fluid pressure at the interface.

5. A separation process as claimed in any of the claims 1 to 4, characterised in that the separators contain means exerting a chemical action on at least one of the elements at the interface.

6. A separation process as claimed in any of the claims 1 to 5, characterised in that the cavities are obtained by engraving.

7. A separation process as claimed in any of the claims 1 to 6, in which the adherence faces define at least one of the said interface zones, and in which the cavities (16) are made at the periphery of at least one element, in the adherence faces.

8. A separation process as claimed in any of the claims 1 to 6, characterised in that the cavities (26) are made in an inner region of at least one element, at the interface.

9. A process as claimed in any of claims 1 to 8, characterised in that at least one cavity penetrates through at least one element from side to side.

10. A separation process in claim 1, characterised in that, where several interface zones are planned, the latter are arranged so as to initiate the separation at determined locations of the interface.

11. A separation process in claim 3, characterised in that, with the fluid being a liquid fluid, the separators involve microwave excitation of the liquid fluid.

12. A separation process in claim 1, characterised in that the two elements adhere to one another with a different adherence energy in different regions of an adherence interface between the elements, so as to initiate separation at a determined location of the adherence interface.

13. A separation process in claim 1, for separating two elements of a structure having at least a first interface formed at the adherence faces of the two elements, and at least one second interface formed in at least one of the elements, in which a separation of the structure is induced at one of the first and second interfaces.

14. A process in claim 13, for the separation of a structure with a bonding energy in the second interface lower than a bonding energy of the first interface, in

which a separation of the structure in the second interface is induced.

15. A process in claim 13, in which, before the two elements are brought into contact, an embrittled zone is formed in at least one of the two elements forming the said second interface.

16. A process in claim 15, in which the embrittled zone is formed using an implantation technique or using a layer adherence technique.

17. A process in claim 15, in which an embrittled zone is formed at a shallow depth in one of the elements such that the second interface delimits a thin layer in the said element.

18. A device for separating two elements of a structure, adhering to one another by adherence faces at least one of which has cavities in an interface zone so as to be able to subject at least one of the adherence faces to the influence of a fluid and possibly to a mechanical action, where the device contains an enclosure with at least a first chamber (11, 35), called the high-pressure chamber, able to receive the fluid, and at least one second chamber (12, 13, 31, 32), called the low-pressure chamber, and where the enclosure is formed so as to receive the two adherent elements such that the cavities communicate with the high-pressure chamber.

19. A separation device in claim 18, characterised in that it also contains means forming a stop (14, 15; 34) on occurrence of deformation judged to be excessive of one and/or the other element of the structure when they are separated.

20. A separation device as claimed in either of claims 18 or 19, characterised in that the means for holding the structure contain at least one joint (7, 8; 27, 28) arranged between an element of the structure and a wall of the enclosure (4, 24).

21. A separation device in claim 20, in which at least one joint is arranged between a main face of at least one element in the form of a plate and a wall of the enclosure facing the main face.

22. A separation device in claim 20, in which at least one joint is arranged between the edge of at least one element in the form of a plate and a wall of the enclosure facing the edge.

23. A handle for transferring objects characterised in that it has an adherence face with cavities in at least some interface zones, and to which objects can adhere, and in that it also has means of access to interface zones in order to separate the objects from it.

24. A transfer handle in claim 23, characterised in that it has a plate, one face of which constitutes the adherence face, and where the plate is pierced with holes (54) which penetrate through, emerging at the interface zones and constituting the said means of access to the interface zones.

25. A transfer handle in claim 24, characterised in that the penetrating holes (54) are holes allowing a tool for separating the objects to pass through.

26. A transfer handle as claimed in any of claims 23 to 25, characterised in that the means of access to the interface zones are channels for the application of a pressurised fluid (104c, 140e, 140f, 104g, 104h, 104i).

27. A transfer handle in claim 26, containing channels for the application of a fluid made in the adherence face and formed according to a concentric circle pattern, a spiral pattern, a radial pattern, or a diagonal intersecting pattern between sectors of the adherence face.

28. A transfer handle in claim 26 in which the channels constitute cavities and/or link cavities (104d) made in the adherence face.

29. A process for transferring objects made on the surface of a first substrate (50), where the objects have

an adherence face, and where the process comprises the following stages:

- the adherence faces of one or more objects (52) are brought into contact with the adherence face of a transfer handle (53) as claimed in any of claims 23 to 21,

- possibly, the first substrate (50) is thinned on the free face of this first substrate,

- at least one of the said objects (52) is brought into adherent contact with a receiving substrate (55),

- the said object is separated from the handle.

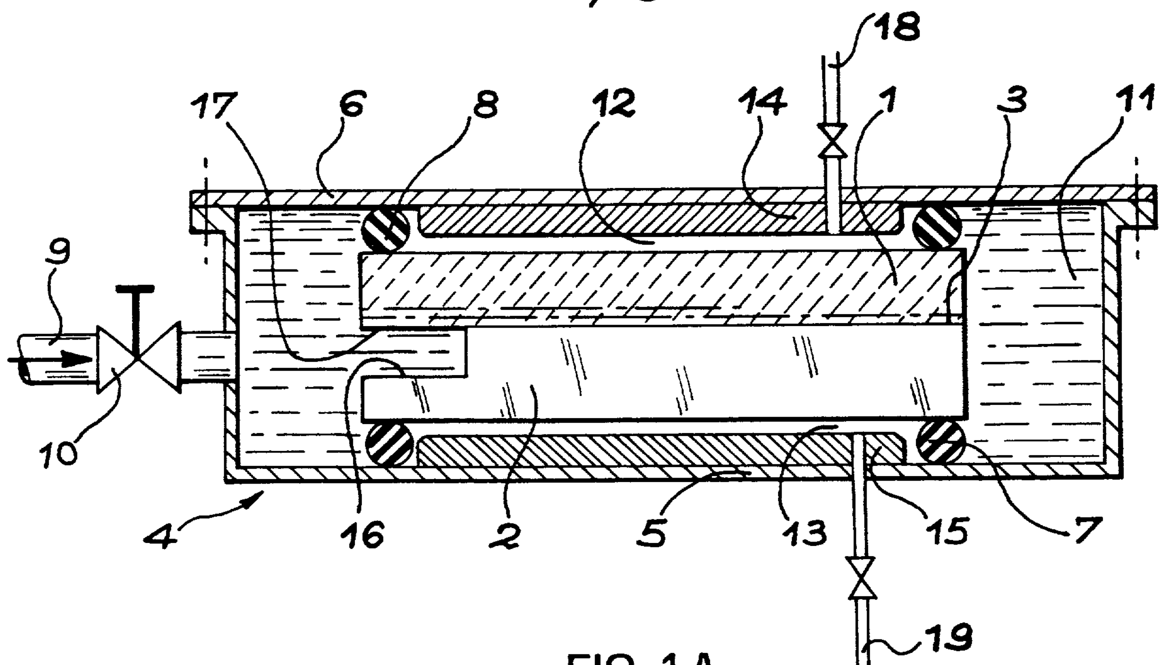
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FIG. 1A

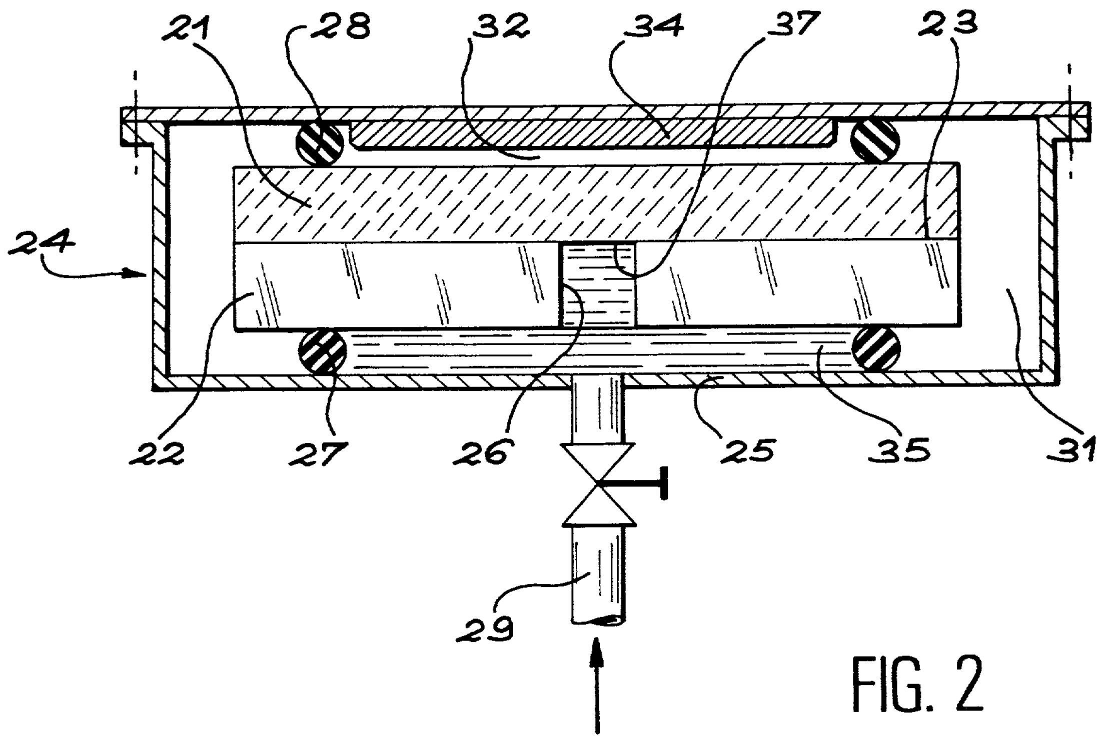
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FIG. 2

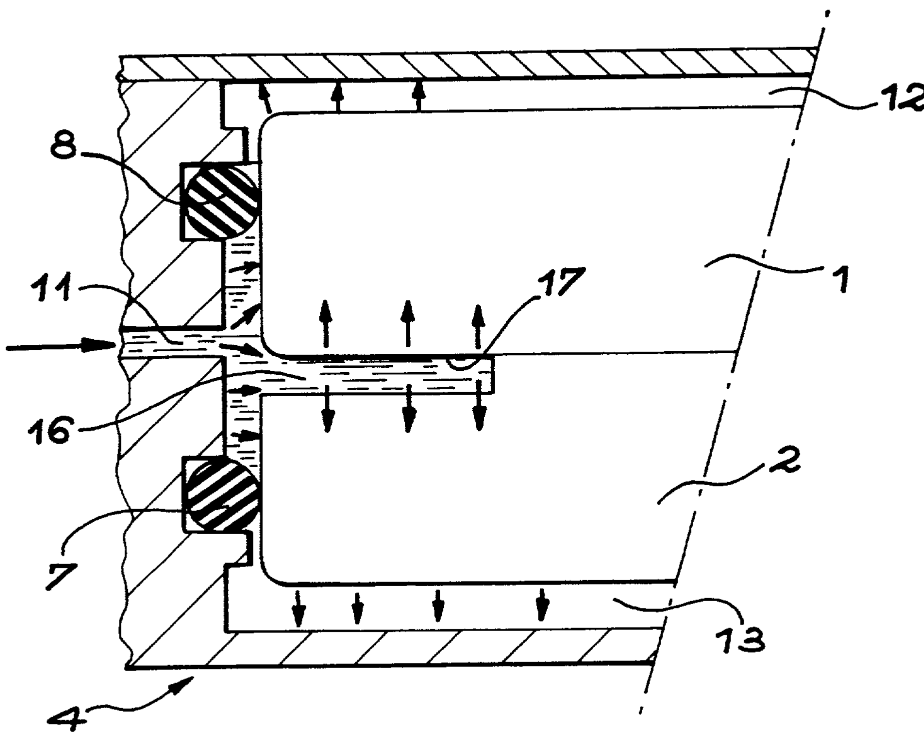

FIG. 1B

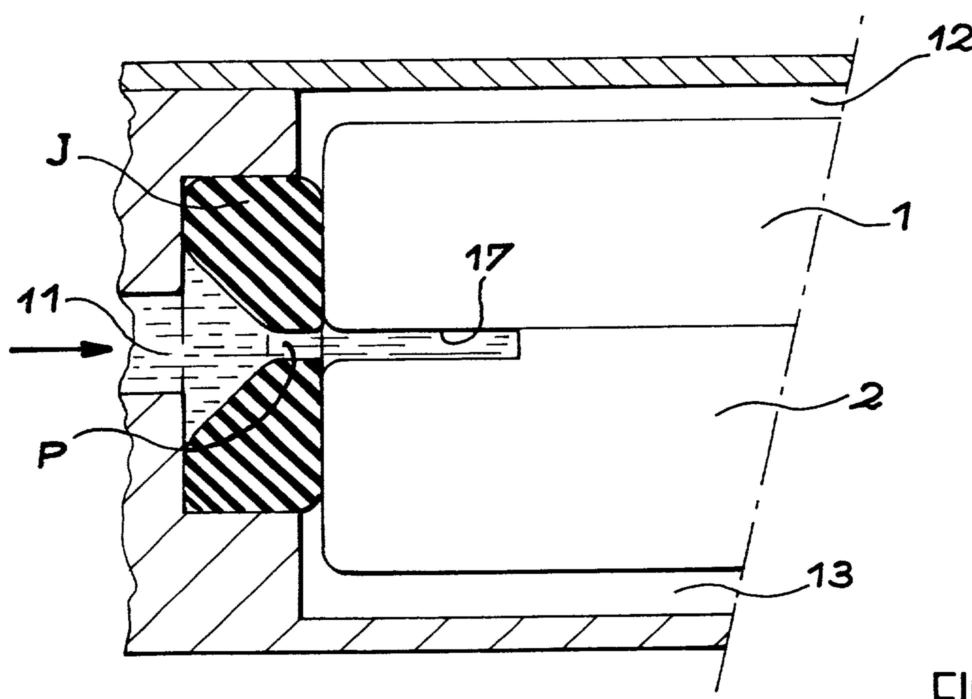

FIG. 1C

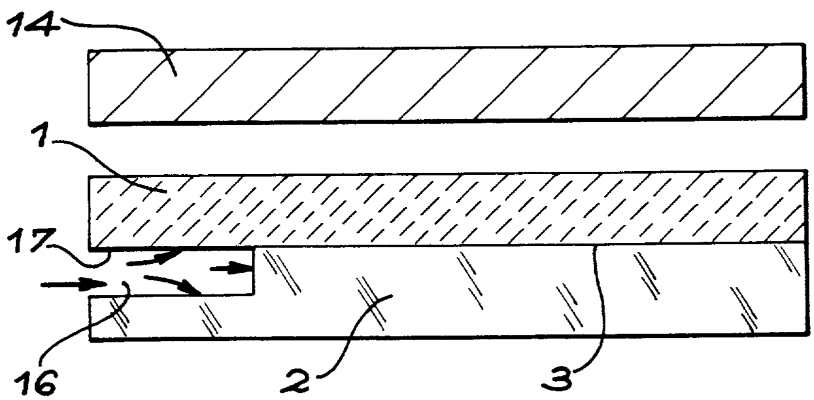

FIG. 3A

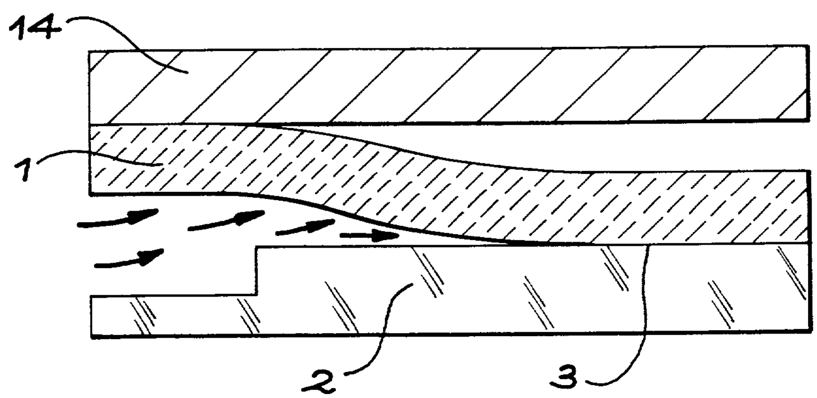

FIG. 3B

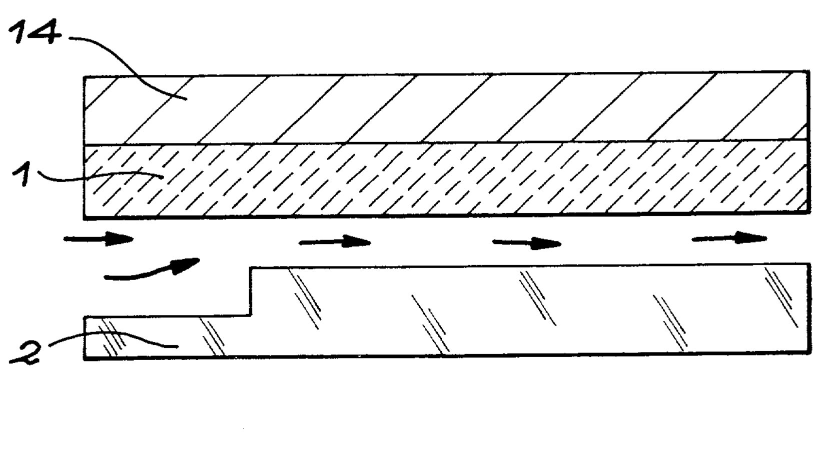

FIG. 3C

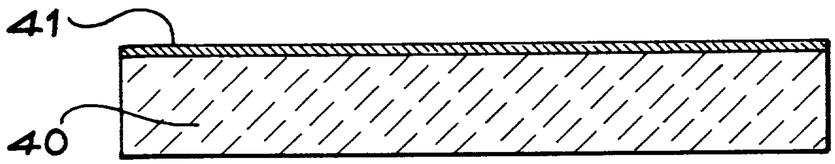

FIG. 4 A

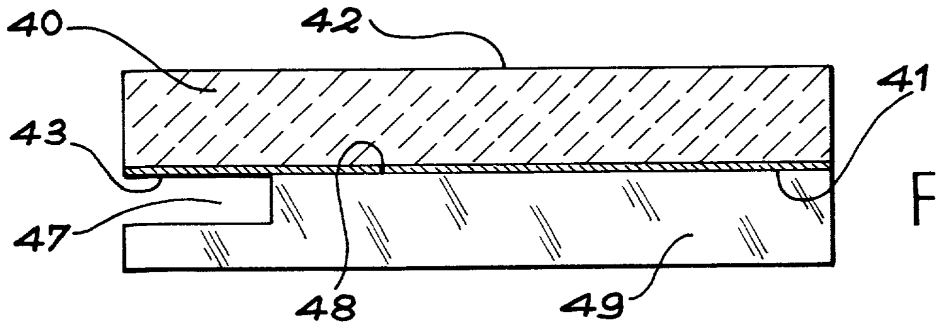

FIG. 4 B

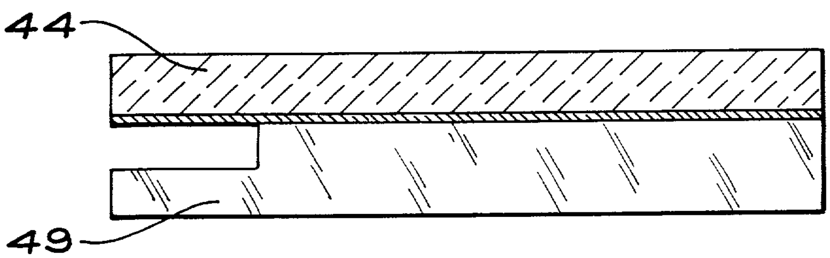

FIG. 4 C

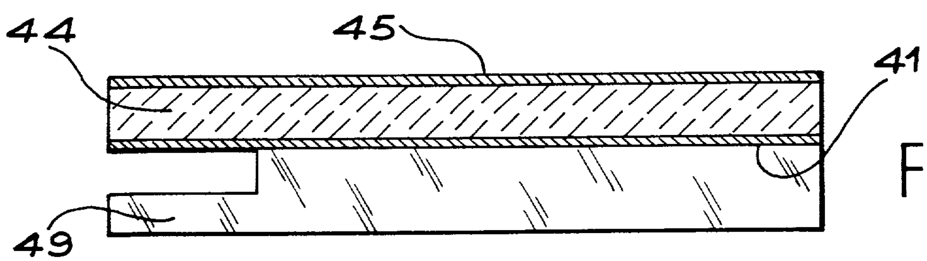

FIG. 4 D

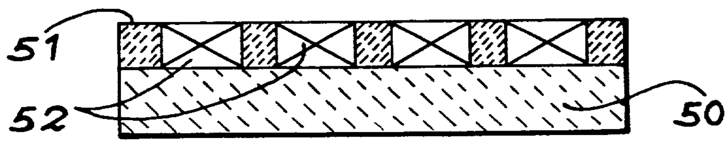

FIG. 5 A

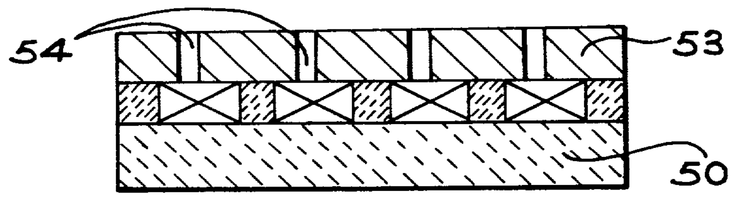

FIG. 5 B

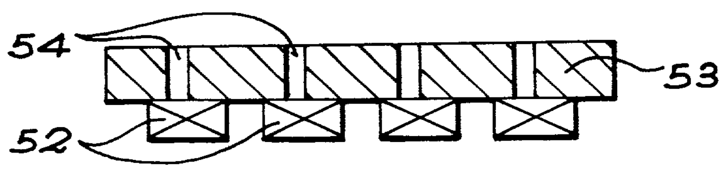

FIG. 5 C

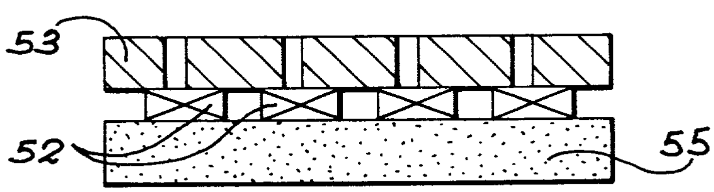

FIG. 5 D

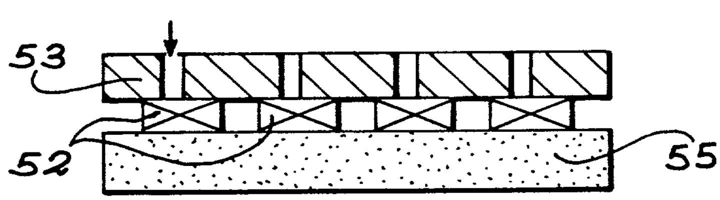

FIG. 5 E

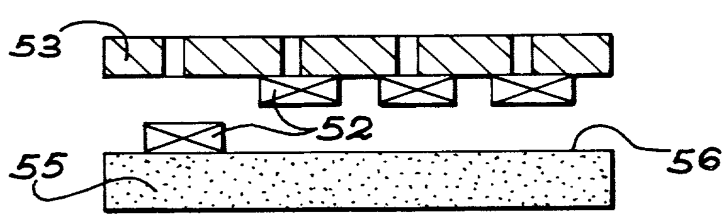

FIG. 5 F

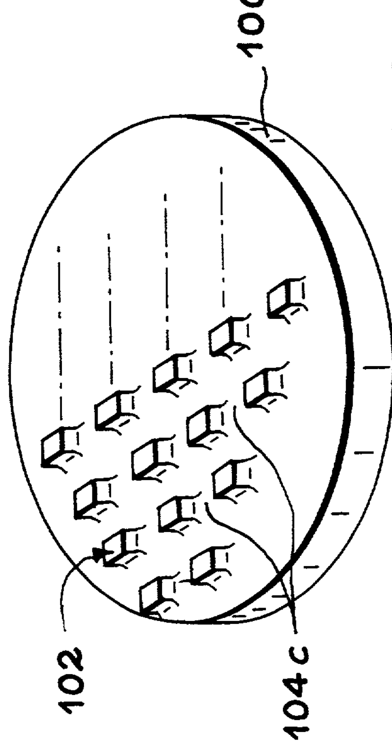

FIG. 8

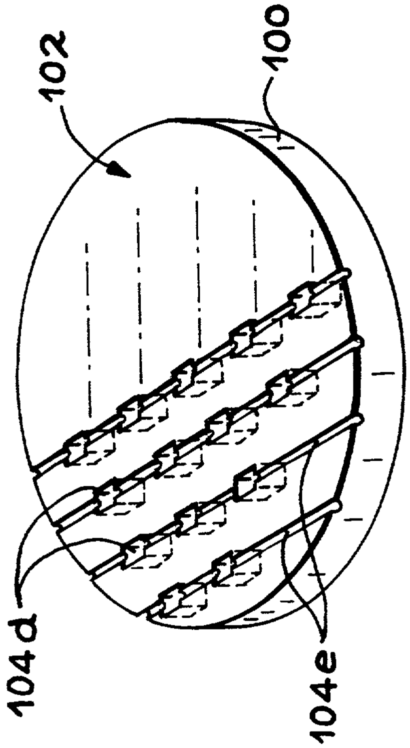

FIG. 9

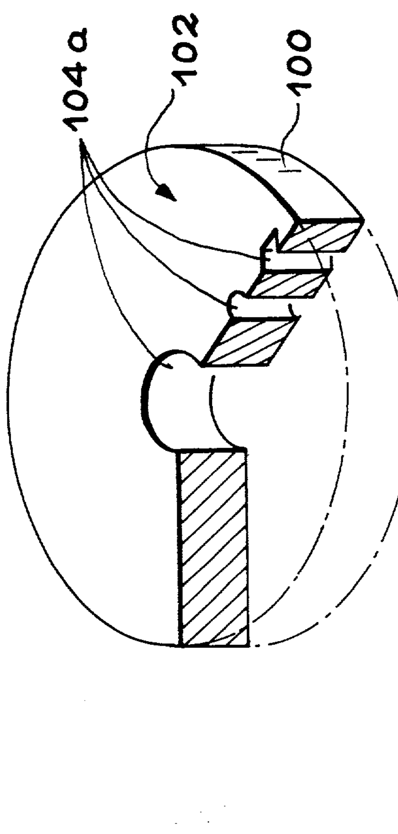

FIG. 6

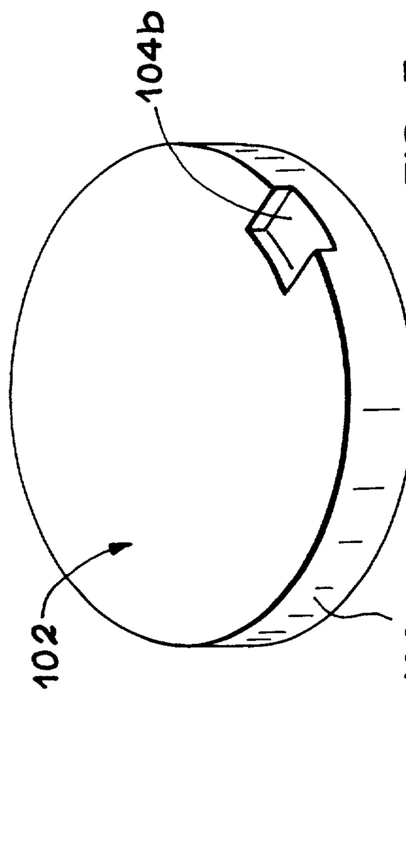

FIG. 7

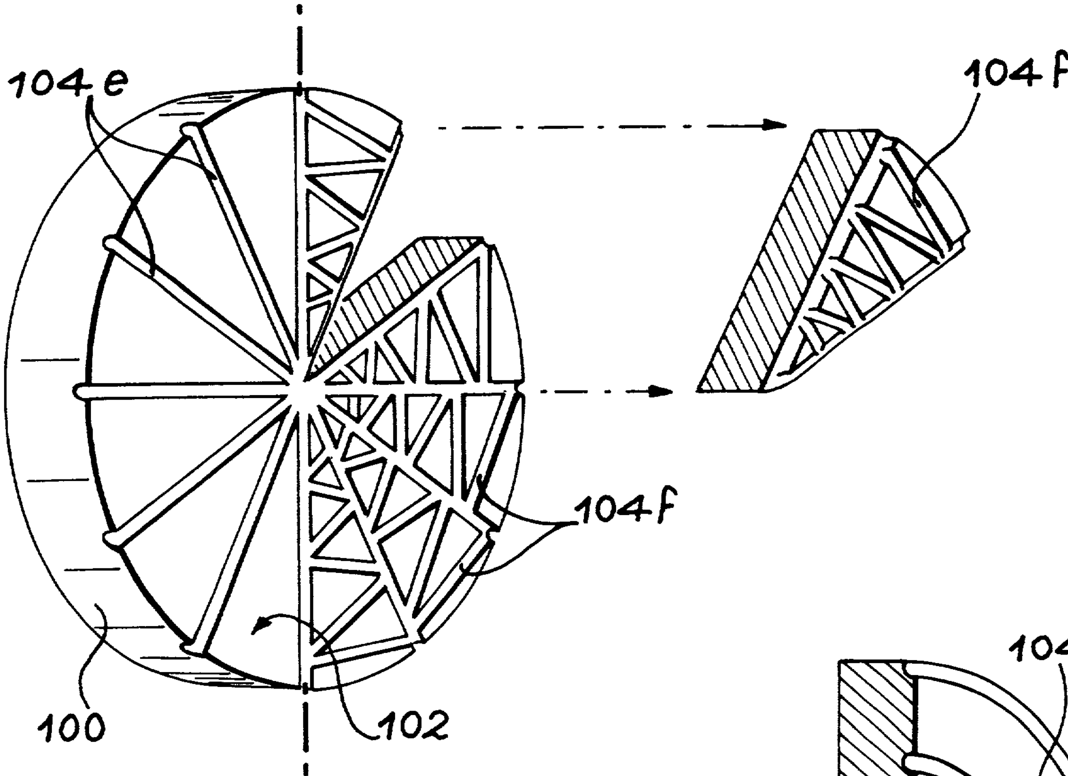

FIG. 10

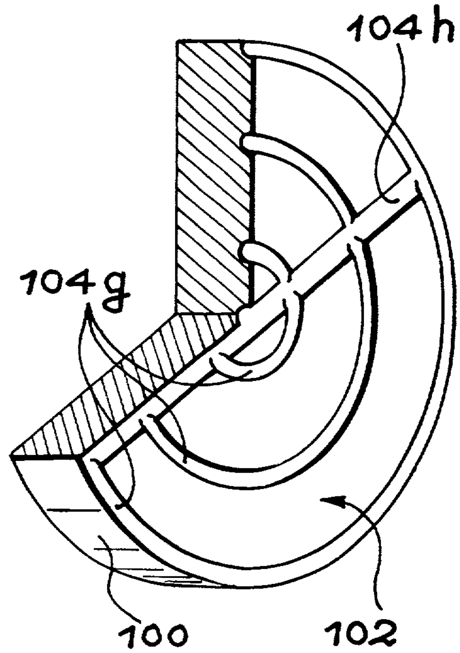

FIG. 11

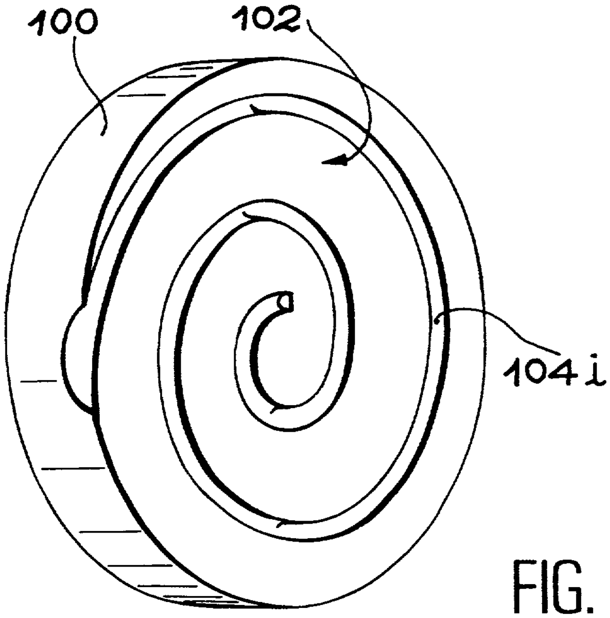

FIG. 12

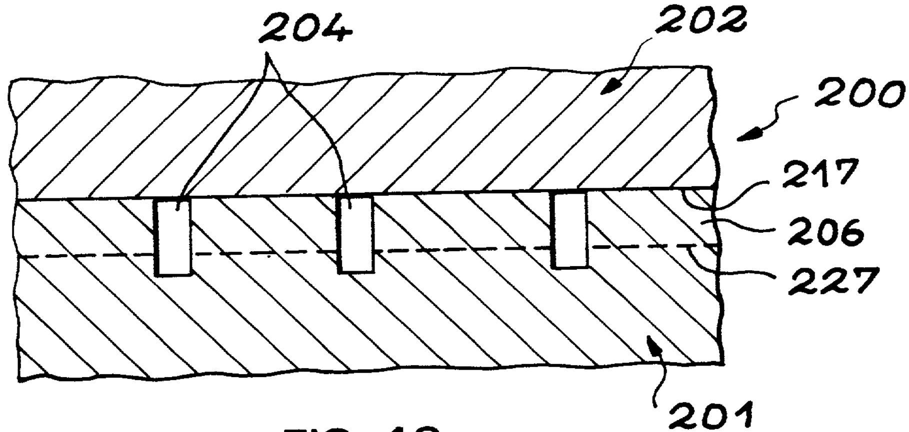

FIG. 13

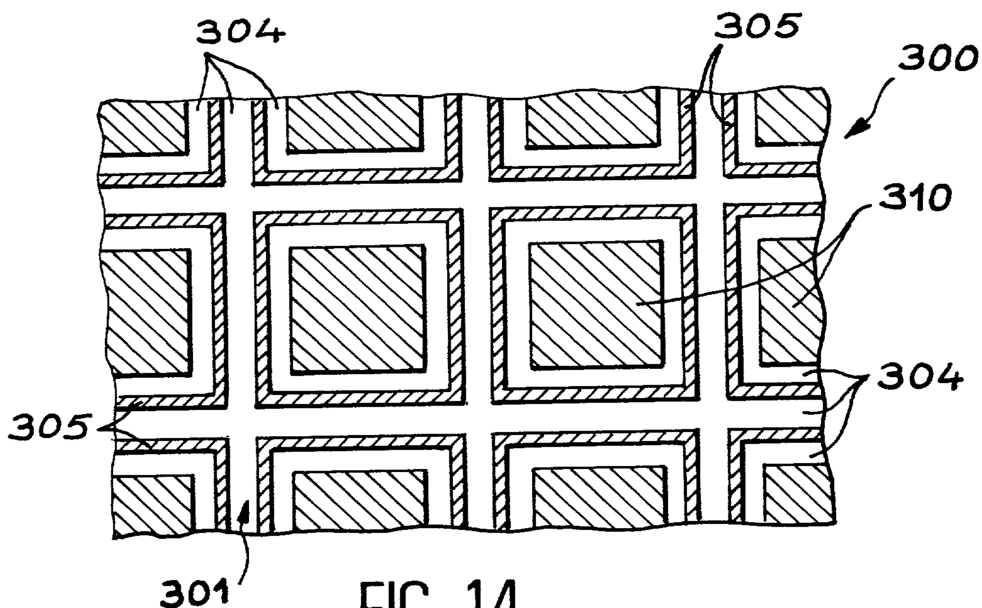

FIG. 14

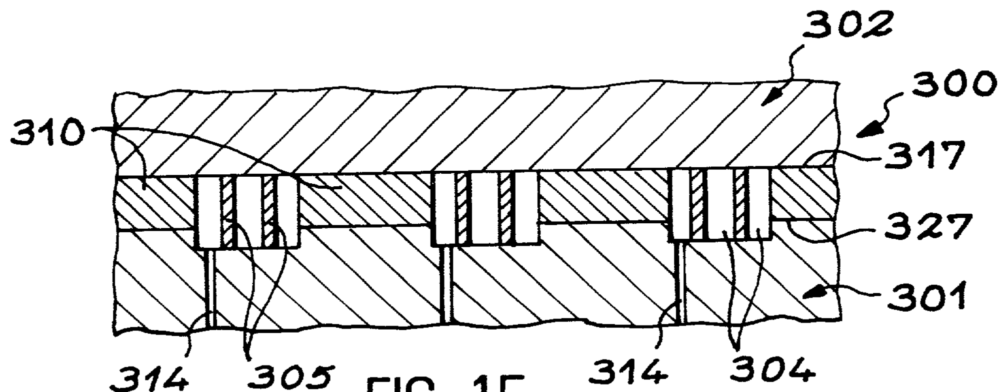

FIG. 15

B 13319.3 EW

Declaration, Power Of Attorney and Petition

WE (I) the undersigned inventor(s), hereby declare(s) that :

My residence, post office address and citizenship are as stated below next to my name,

We (I) believe that we are (I am) the original, first, and joint (sole) inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled

PROCESS FOR SEPARATION OF TWO ELEMENTS AND DEVICE FOR ITS IMPLEMENTATION

the specification of which

☐ is attached hereto.

☐ was filed on

as Application Serial No.

and amended on

☒ was filed as PCT international application

Number PCT/FR00/02014

on July 12, 2000

and was amended under PCT Article 19

on October 09, 2001

We (I) hereby state that we (I) have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

We (I) acknowledge the duty to disclose information known to be material to the patentability of this application as defined in Section 1.56 of Title 37 Code of Federal Regulations.

We (I) hereby claim foreign priority benefits under 35 U.S.C. § 119 (a)-(d) or § 365 (b) of any foreign application(s) for patent or inventor's certificate, or § 365 (a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed. Prior Foreign Application (s)

Application No.	Country	Day/month/Year	Priority Claimed
99 09007	FRANCE	12 JULY 1999	☒ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO

We (I) hereby claim the benefit under Title 35, United States Code, § 119 (e) of any United States provisional application(s) listed below.

(Application Number)	(Filing Date)
(Application Number)	(Filing Date)

We (I) hereby claim the benefit under 35 U.S.C. §120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of prior application and the national or PCT International filing date of this application.

Application Serial No.	Filing Date	Status (pending, patented, abandoned)

And we (I) hereby appoint : Norman F. Oblon, Registration Number 24,618; Marvin J. Spivak, Registration Number 24,913; C, Irvin McClelland, Registration Number 21,214; Gregory J. Maier, Registration Number 25,599; Arthur I. Neustadt, Registration Number 24,854; Richard D. Kelly, Registration Number 27,757; James D. Hamilton, Registration Number 28,421; Eckhard H. Kuesters, Registration Number 28,870; Robert T. Pous, Registration Number 29,099; Charles L. Gholz, Registration Number 26,395; Vincent J. Sunderdick, Registration Number 29,004; William E. Beaumont, Registration Number 30,996; Steven B. Kelber, Registration Number 30,073; Robert F. Gnuse, Registration Number 27,295; Jean-Paul Lavalleye, Registration Number 31,451; William B. Walker, Registration Number 22,498; Timothy R. Schwartz, Registration Number 32,171; Stephen G. Baxter, Registration Number 32,884; Martin M.,. Zoltick, Registration Number 35,745; Robert W. Hahl, Registration Number 33,893; and Richard L. Treanor, Registration Number 36,379; our (my) attorneys, with full powers of substitution and revocation, to prosecute this application and to transact all business in the Patent Office connected therewith; and we (I) hereby request that all correspondence regarding this application be sent to the firm of OBLON, SPIVAK, McCLELLAND, MAIER & NEUSTADT, P.C., whose post Office Address is : Fourth Floor, 1755 Jefferson Davis Highway, Arlington, Virginia 22202.

We (I) declare that all statements made herein of our (my) own knowledge are true and that all statements made on information and belief are believed to be true ; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such wilful false statements may jeopardise the validity of the application or any patent issuing thereon.

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Signature of Inventor

Date

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